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(54) Controlling the execution of host computer application programs through a second computer.

(57) Method and apparatus for executing a computer application program in a host computer under the control of a second computer located at a workstation include the steps of translating selected portions of the host computer's presentation information into functionally equivalent user-oriented presentation information for use in the second computer, and translating a user's responses to the user-oriented presentation information at the second computer into response information for use in the host computer to interact with the application program.

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Figure 1
Architecture Overview

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CONTROLLING THE EXECUTION OF HOST COMPUTER APPLICATION
PROGRAMS THROUGH A SECOND COMPUTER
DESCRIPTION

This invention relates to the execution of computer application programs in a host computer under the control of a second computer, which can be a less powerful computer.

There is a need in the data processing field for a single product configuration capable of addressing the following requirements in the computer industry:

1. The ability to develop and operate "user friendly" interfaces which, by providing added functional capability (such as integration of application data), result in computers which have a high degree of consistency and ease of operation through the use of techniques such as high function representations in the form of graphic icons and other graphics, and which will be relatively easy for a user to learn, preferably in an intuitive way.
2. The ability for new computer environments to operate existing software packages, without modifications to those packages, and to retain the benefits currently found for those applications which run in a multiuser, multitasking, centralized computer which provides a high degree of storage capacity, processing capacity and information management services.
3. A method for transferring and exchanging data among various different applications and host computers.

Although there are various approaches which provide partial solutions to these problems, presently there is

1 no set of products designed specifically to address all
2 of these requirements. The current approaches fall into
3 two categories:

4 1. Move the application functionality to a cost
5 effective, user-friendly, computer workstation environ-
6 ment which provides both the hardware and software tools
7 and technology to add the functionality of a user-friendly
8 interface to the application. For most business application
9 uses, this computer workstation environment is obtained
10 through the use of the class of microcomputers known as
11 personal computers.

12 Although this approach has been used to effectively
13 provide the benefit of the user-friendly interface,
14 moving the application functionality involves various
15 amount of reengineering and rewriting in order to move,
16 or "port", the application to this computer workstation
17 environment. The costs of such reprogramming often makes
18 this approach undesirable.

19 In addition, if the entire application software and
20 data files are moved to this workstation environment, the
21 workstation capacity, due in part to its cost effectiveness,
22 often becomes a problem and the processing capacity required
23 to provide the user-friendly interface functions plus the
24 application processing is often beyond the capabilities
25 of this workstation environment. In addition, the micro-
26 processor technologies used in these workstations are
27 often limited in the amount of storage which the work-
28 station is capable of accessing. Even where the storage
29 capacity is available in this workstation environment,
30 the problems of distributed information management often
31 outweigh the advantages obtained.

32 A hybrid approach allows the application software to
33 operate in a secondary computer workstation but the data
34 files remain in the multiuser, multitasking, centralized
35 computer. This approach has the advantage of providing
36 the centralized information management services and the
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1 user-friendly interface while retaining, and even increasing,
2 the capacity of the multiuser, multitasking, central
3 computer. Since this approach involves a secondary-to-host
4 computer link, accessing data over that link often presents
5 severe performance limitations. The costs of moving the
6 application remain a disadvantage. In addition, the
7 processing capacity required to provide the user-friendly
8 interface functions plus the application processing
9 is often beyond the capabilities of this workstation
10 environment.

11 2. Add the user-friendly interface functionality
12 to a multiuser, multitasking, centralized computer which
13 provides a high degree of storage capacity, processing
14 capacity, information management services.

15 Attempts to program the centralized computer to
16 perform the user-friendly functions are usually limited by
17 a lack of hardware, software tools and technology to
18 provide such functions.

19 The hybrid approach involves the use of an intelligent
20 terminal or computer workstation in conjunction with the
21 reprogramming of the central computer. In this approach,
22 the application in the central computer is programmed to
23 direct the workstation to perform many of the user-friendly
24 functions at the appropriate time during the execution of
25 the application. Adding the user-friendly interface
26 functionality involves the various amounts of reengineering
27 and rewriting of the application. The costs of such
28 reprogramming often makes this approach undesirable. In
29 addition, such an approach, to provide the maximum benefit,
30 would obsolete the existing terminals used with the
31 application.

32 The present invention accordingly uses a secondary
33 computer communicating with an existing multiuser,
34 multitasking, high capacity, centralized computer to
35 provide the tools

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1 and technology which allows the development and operation
2 of adaptive, user-friendly interfaces to existing applica-
3 tion software packages operating in that centralized
4 computer. The invention allows the secondary computer to
5 function as a distributed processor, operating in conjunc-
6 tion with the central computer to perform the functions
7 required to provide a user-friendly interface.

8 The invention also provides a machine-independent,
9 information-exchange environment and subsequent method for
10 transferring and exchanging data among applications and
11 hosts. Furthermore, the invention provides the added
12 functionality without requiring the application software
13 in the centralized computer to be changed in any way.

14 Utilizing this invention presents an environment
15 which provides a standardized style and manner by which
16 the user interacts with various, different applications.
17 The present invention distributes the functions of access-
18 ing and interacting with one or more host applications
19 and providing a user-friendly interface for each applica-
20 tion, such that new or existing full featured business
21 applications can run unencumbered in the more powerful
22 host computer while the majority of the power of the
23 secondary computer can be used to present the user with a
24 state-of-the-art, user-friendly interface to the applica-
25 tion(s). Thus, many of the performance limitations of a
26 secondary computer are avoided.

27 The secondary computer, which can be described as a
28 very intelligent workstation, changes the user's environ-
29 ment from one in which a user must adapt to a fixed
30 interface for each application and a fixed method of
31 operating the secondary computer (or alternately, a
32 present-day computer terminal) to one in which the user
33 defines the way he wishes to interface to the application
34 even though the application interface in the actual host
35 application remains fixed. As a result of this invention,

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1 there is no need to modify the vast libraries of business
2 application software to provide such an interface.
3 Transitions in conditions required to accomplish that
4 interface are performed by the secondary computer (work-
5 station) through the architecture of this invention.

6 Since the application remains in the host computer
7 and only a relatively small set of translation instruc-
8 tions, called an application interface module (AIM), may
9 be downloaded to be executed by the secondary computer,
10 the problems associated with the relatively small memory
11 of the secondary computer are overcome. Also, since only
12 the AIM and data that has been used or changed by the
13 user needs to be moved from or to the host system, perfor-
14 mance delays typical of more conventional systems are
15 overcome.

16 Additionally, since the environment created by the
17 invention fully supports multiple sessions in support of
18 applications running on a single host or on separate
19 hosts, and since the environment translates all applica-
20 tions user interface operations such that, while being
21 operated on by way of the secondary computer, they all
22 have a common data and interaction form, interchange and
23 integration of information between any application becomes
24 a readily available facility to the user. In addition,
25 data or graphic information derived from the host applica-
26 tion but created in the secondary computer can be appended
27 to the information that is a part of the application in
28 the host system.

29 That is, the secondary computer presents the same
30 familiar user friendly interface to the user for a variety
31 of application programs to be run, thus eliminating the
32 need for the user to learn the often complicated details
33 of interfacing with a variety of different application
34 programs, while still making available to the user the
35 benefits of these application programs. Additionally,
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this solution avoids the complexity and maintenance costs of distributed information management.

5 A multiuser multitasking host computer employing the present invention and using the secondary computer as a terminal can continue to be a node in a networking environment, should the user's needs require a network.

Thus it will be evident that the present invention can be embodied so as to meet the requirements stated in 1, 2 and 3 above.

10 The invention is further explained below, by way of illustration, with reference to the accompanying drawings, in which;

Fig. 1 illustrates an architecture overview of a system embodying the present invention;

15 Figs. 2a, 2b and 2c, when placed side by side, illustrate the general flow of information through the present system;

Fig. 3 illustrates the input stream processing in the system of the invention;

20 Figs. 4 and 5 illustrate display processing and display updating, respectively;

Fig. 6 illustrates keystroke processing;

Fig. 7 illustrates mouse processing;

25 Figs. 8 and 9 show AIM initialization and signal processing, respectively;

Fig. 10 illustrates the rule processing detail; and

Figs. 11 and 12 are examples of Rule Sequence and Rule Execution tables, respectively.

30 The illustrated embodiment of the present invention will be described by first providing an overview of the architecture thereof.

Architecture Overview

35 The workstation of the present invention connects to a host computer in the usual manner. As shown in Fig. 1,

1 the user communicates with a host application program in
2 the host computer 11 through the present workstation
3 using a keyboard, a display screen 13, and optionally, a
4 mouse. Information is presented on the screen 13 through
5 a set of icons, secondary computer-style windows and
6 pull-down menus.

7
8 The host's "screen" information and the user's
9 reactions to that information may be modified by means
10 of a set of translation functions which are defined by
11 the application interface modules (AIM). Since the AIM
12 functions are executed by the workstation, the load on
13 the host processor 11 may be reduced.

14 15 Run-time System and Tools

16
17 The run-time system provides the interface between
18 the secondary computer native operating system and the
19 various modules and tools operable within the environment
20 of the invention. The operating run-time system supplies
21 many generalized functions and tools which are used
22 during the development and execution of an AIM.

23
24 The central event/time monitor, a major portion of
25 which may be supplied by the native operating system for
26 the secondary computer, is the focal controlling function
27 within the present operating run-time system. The central
28 event/time monitor buffers the interrupt-driven events
29 (e.g., arriving characters, keyboard and mouse operations)
30 and performs the distribution of those events to the
31 time-driven operations (e.g., display screen updating)
32 and to the event-driven operations (e.g., AIM processing).
33 In addition, the central event/time monitor provides the
34 "process" distribution (i.e., which AIM is to be employed)
35 and the prioritization services.

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1 Communication Functions

2
3 The host computer 11 communicates with the workstation
4 through the comm(unication) functions element 16. The
5 input and output communication functions provide the
6 interface between the terminal emulator 17 and the host 11.
7 These functions provide the required secondary-to-host
8 link-level protocol (e.g., packetizing/depaketizing,
9 error control, flow control, etc.) and the multiplexor/
10 demultiplexor switching function necessary to support
11 multiple, concurrent, virtual terminal sessions.

12
13 In the input mode, communications functions element 16
14 receives the data stream which has been conditioned by
15 host 11 according to the communications protocol and,
16 after performing the necessary operations required to
17 remove the communications protocol from the data stream,
18 passes the data stream to terminal emulator 17. In the
19 output mode, communication functions element 16 accepts
20 characters from terminal emulator 17, conditions the data
21 stream according the communications protocol, and transmits
22 the data to host 11.

23
24 A different set of communications functions is
25 usually required for each class of communication link
26 hardware and/or protocol supported (e.g., RS-232/C,
27 Ethernet, Apple-Bus, etc.). Furthermore, since communi-
28 cation functions must be supported by host 11, the set of
29 communication functions for any given secondary-to-host
30 connection is usually defined at the time of physical
31 connection and remains relatively fixed.

32
33 A given set of communications functions may support
34 a set of link-level protocols and a set of multiplexing/
35 demultiplexing (Mux/DeMux) protocols. A different Mux/DeMux
36 is usually required for each class of host protocol
37 supported (e.g., 3270 Bisynchronous (BSC) and System
38 Network Architecture (SNA), etc.).

1 Terminal Emulator

2 Terminal emulator 17 performs two sets of translations:

3 The incoming, terminal-dependent data is trans-
4 lated to a secondary environment-dependent, internal
5 ("universal") representation for use by the remainder
6 of the system.

7 The outgoing "universal" (secondary computer-
8 dependent) data is translated to a terminal-dependent
9 data stream for use by the host application.

10
11 Terminal emulator 17 receives the incoming data
12 stream originally generated by the host application
13 program from communications functions 16. The emulator's
14 outgoing data stream is generated by mouse and keyboard
15 operations after the events have been processed by the
16 keyboard and mouse processor 18.

17
18 Since the incoming data stream is translated to the
19 internal representation used within the secondary computer,
20 a library of control functions is accessible to perform
21 the various terminal functions. Furthermore, once a
22 routine is developed to perform, for example, a screen
23 control operation, that routine may be used in a "mix and
24 match" manner during the development of other terminal
25 emulators. The present invention environment provides a
26 library of common screen control functions to choose
27 from. In essence, the terminal emulator presents a
28 predefined, terminal-independent interface to the AIM.
29 Terminal emulator 17 also performs "local" operations
30 normally present in the terminal being emulated (e.g.,
31 block mode transmission, programmable function key cap-
32 abilities, etc.).

33 34 Virtual Terminal Buffer

35 The virtual terminal buffer 19 contains the host's
36 screen information. Since all information contained

37

38

1 within the normal host screen is represented in a consis-
2 tent, internal format, the virtual terminal buffer is the
3 reference point for interaction with the host application.

4 Application Interface Module (AIM)

6 The AIM, represented symbolically as 21 in Fig. 1,
7 is the mechanism which provides the unique, host applica-
8 tion-dependent working environment within the secondary
9 computer workstation. The AIM is where the user interface
10 characteristics relative to the host's application are
11 implemented. In essence, the AIM provides two sets of
12 translations:

13 The host's "screen" presentation is translated
14 to a functionally equivalent, user-oriented presen-
15 tation of the information.

16 The user's actions, resulting from the user's
17 view of the host application program as presented at
18 the secondary computer, are translated to the appro-
19 priate "keystrokes" required by the host application.

20
21 This has the advantage that the user at the workstation
22 employing the AIMS need not have any detailed knowledge
23 of, or training on, the host computer to be able to cause
24 execution of the selected application program on the host
25 computer under the control of the user at the workstation.
26 The user may interact at the workstation using the user
27 friendly interface thereof, including icons and other
28 features of this interface, with which he is familiar.

29
30 The AIM logically consists of two major components,
31 a host data stream processor 22 and the various mouse and
32 keyboard processors 18.

33 AIM Input Data Processor

34
35 The host data stream processor 22 analyzes and
36 processes the data stream from host 11 relative to the
37 virtual terminal buffer 19. It is only through this
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1 analysis that the host application program can be "under-
2 stood". Most translations of the host's screens are
3 performed by the host data stream processor (e.g., rear-
4 ranging display areas and changing character fonts before
5 presentation to the user).

6

7 Mouse and Keyboard Processors

8 The mouse and keyboard processors 18 analyze and
9 process the data stream from the mouse and keyboard
10 relative to the virtual window buffer. It is only through
11 this analysis that the user can be "understood" and
12 related back to the host "screen". Most translations of
13 the user's actions are performed by mouse and keyboard
14 processors 18 (e.g., sending characters as a result of
15 pull-down menus, cursor positioning by pointing, etc.).

16

17 Virtual Window Manager

18

19 The virtual window manager 26 performs most of the
20 common but complex operations necessary to manage the
21 presentation of information from the virtual terminal
22 buffer 19 on screen 13. The "normal" secondary computer
23 window environment is transparently available to the host
24 application through the AIM to present workstation displays
25 (e.g., HELP information, status queries, etc.). In
26 addition, virtual window manager 26 provides much of the
27 mouse-event processing (e.g., cursor movement by pointing,
28 area selection, etc.) and supplies the functions required
29 to relate the user's presentation to the host's presenta-
30 tion (ie., the mapping of the virtual window buffer to
31 the virtual terminal buffer).

32

33 Virtual Window Buffer

34 The virtual window buffer 27 contains the user's
35 view of the host's application "screen". Since the
36 information to be displayed to the user is represented in
37 a consistent, internal format, virtual window buffer 27
38 is the reference point for interaction with the user.

1 AIM Development Process

2 The AIM development process is primarily one of
3 table specification and editing. A significant percentage
4 of the work is in the characterization of the interface.
5 Once the interface has been characterized, the various
6 components of the interface may be specified. Given a
7 "template" AIM, known as a terminal emulator or "pass-
8 through" AIM, the "developer" first creates the various
9 types of secondary computer resources (i.e., tables and
10 functions) required by AIM (e.g., menus, dialogs, windows.)
11 The "empty" predefined AIM resources, called Rule Tables,
12 are edited to "program" the application-specific interface
13 operations. Once the Rule Tables have been completed,
14 the AIM resources may be checked, parsed, optimized,
15 tokenized and linked by the AIM generator. The resulting
16 AIM may be installed on the host using the present func-
17 tions of the secondary computer.

18 19 OVERVIEW OF OPERATIONS

20
21 The discussion below follows some host-generated
22 data (a "screen-full", for example), through the present
23 system, describing the operations resulting from a user's
24 response to this data, and the data sent back to the host
25 as a result of the AIM's translation of the user's actions.
26 This portion of the discussion does not consider the
27 detailed contributions of the workstation's native operat-
28 ing system or the run-time environment. Instead, the
29 discussion assumes that the host connection and log-in
30 procedures have been performed, that the host application
31 has been brought into play and that the appropriate AIM
32 has been initialized in the workstation. The AIM consists
33 of various resources which direct the operation of the
34 run-time system.

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1 AIM Initialization

2 Reference may now be had to Figs. 2a, 2b and 2c
3 which, when laid side by side, show an overview of the
4 system operation. When an AIM is loaded into the run-time
5 system, initialization processor 8 (Fig. 2a) performs the
6 functions required to "get an AIM started" (e.g., create
7 a window, etc.). In short, the AIM initialization processor
8 sets the beginning environment for the AIM.

9

10 AIM Signal Processing

11 At various times during the execution of an AIM,
12 different events may occur which are not otherwise handled
13 during the normal flow of events. Such events may be
14 defined as signals to be processed by the AIM signal
15 processing subsystem. The signal processor 9 performs
16 the functions required to respond to the various stimuli
17 defined as signals (e.g., events such as activate window
18 or messages such as "physical host connection lost",
19 etc.).

20

21 Host Data Stream Input

22 The "screenful of data" generated by the host enters
23 the workstation by way of the host data stream input
24 subsystem. The host data stream input subsystem contains
25 both the link-level communication protocol driver 31
26 (Fig. 2b) and demultiplexor functions 32. Generally, the
27 native environment I/O port driver 33 accepts the incoming,
28 host-originated characters and activates the link-level
29 communication protocol driver 31 which, in turn, activates
30 demultiplexor 32. Link-level protocol driver 31 removes
31 the protocol information from the input data stream and,
32 when it has been stripped of all its protocol overhead,
33 it is passed to demultiplexor 32.

34

35 The multiplexor/demultiplexor functions supports the
36 concurrent operation of multiple, virtual circuits over a
37 single physical connection. The demultiplexor removes

38

1 the multiplexing information from the data stream, then
2 places the data in the input queue which consists of a
3 first in-first out (FIFO) input buffer 34 (Fig. 2c)
4 logically attached to the AIM associated with that virtual
5 circuit. The data in the FIFO 34 is identical to that
6 which was generated by the host application, and FIFO 34
7 provides buffering for the input terminal emulator 17a.

8 9 Input Data Stream Processing

10 Once the data has been entered into the workstation,
11 the job of translation can begin. Still referring to
12 Fig. 2c, the input data stream processing subsystem
13 consists of the terminal emulator 17a, virtual terminal
14 buffer 19, AIM input stream processor 20, virtual window
15 manager 26, and virtual window buffer 27 functions.
16 Terminal emulator 17a translates the terminal-specific
17 data into a workstation representation, buffers the
18 information in virtual terminal buffer 19, then notifies
19 AIM input data processor 20 of the arriving characters.
20 AIM input data processor 20 performs any required proces-
21 sing, then passes the characters to virtual window man-
22 ager 26. Virtual window manager 26 maintains virtual
23 window buffer 27 in a manner which allows optimal updating
24 of the workstation screen display. Virtual window buffer 27
25 provides buffering for the bit map update manager 30
26 which is periodically activated to update the workstation
27 display screen.

28 29 Display Processing and Update

30 The display processing subsystem manages the bit-map
31 update functions used to generate the workstation display.
32 Based upon the elapsed time, the bit map update manager 30
33 activates the native bit map update routines. The display
34 update subsystem performs the actual bit map update of
35 the workstation display.

36
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1 Keystroke Processing

2 The keystroke processing subsystem (Fig. 2a) performs
3 the AIM keyboard processor portion of the mouse and key-
4 board processor 18 functions. The keystroke processing
5 subsystem contains the physical keyboard processor 23,
6 menu key processor 24, AIM keystroke processor 25, and
7 output terminal emulator 17b functions.

8
9 Events from the keyboard activate physical keyboard
10 processor 23 which, in turn, activates menu key processor 24.
11 If the keystroke from the keyboard is equivalent to a
12 menu selection, control is passed to AIM menu processor 36
13 (Fig. 2b). Other keystrokes are passed to AIM keystroke
14 processor 25, then to output terminal emulator 17b.
15 Emulator 17b, which may also receive keystrokes from the
16 AIM menu and point processors 36, 37, places the characters
17 in an output FIFO 38.

18 19 Host Data Stream Output

20 The host data stream output subsystem consists of
21 multiplexor 39 (Fig. 2b) and output link-level communica-
22 tion protocol driver 41 functions. The characters to be
23 output are taken from output FIFO 38 and processed by
24 multiplexor 39 and the link-level communication protocol
25 driver 41. When the character stream has been condi-
26 tioned, i.e., its multiplexing and protocol envelope have
27 been added, the I/O port driver 33 from the native environ-
28 ment is used to transmit the characters at the hardware
29 I/O port level. Output FIFO 38 provides buffering from
30 output terminal emulator 17b until multiplexor 39 is
31 activated to process the characters.

32 33 DETAILS OF OPERATION

34 35 Input Stream Processing

36 Referring to Fig. 3, the central event/time monitor 10
37 within the operating run-time system maintains the AIM

1 control tables 28. It is through these tables that the
2 central event/time monitor is able to determine which
3 input FIFO is attached to which virtual circuit.

4
5 When the host data stream arrives at the native
6 environment port, an interrupt is generated which passes
7 control to the port driver routines. The driver routines
8 buffer the arriving characters and communicate with the
9 communication driver. The communication driver, based
10 upon a specified minimum number of characters in the
11 input FIFO 34, gets the buffered characters from the
12 appropriate port driver. After calling the port driver
13 to get a set of characters from the driver's input buffer,
14 driver 33 performs the required buffering, error-checking,
15 error correction and/or transmission procedures, where
16 required. The communication driver, based upon a specified
17 maximum number of characters in input FIFO 34, may also
18 call the port driver to perform flow control. When these
19 operations are completed, the communication driver passes
20 the characters to demultiplexor 32. Demultiplexor 32
21 places the characters into the section(s) of the input
22 FIFO depending upon the virtual circuit to which the
23 characters belong. When complete, control is returned to
24 the central event monitor 10.

25
26 Based upon an elapsed time function, central event/
27 time monitor 10 controls the passing characters to input
28 terminal emulator 17a. Monitor 10 is also responsible
29 for determining and setting the priority for the distri-
30 bution of the host data stream characters. Terminal
31 emulator 17a translates the terminal-specific data into
32 the "universal" representation used in the present inven-
33 tion, buffers the information in virtual terminal buffer 19,
34 then notifies ALM input data processor 20 of the arriving
35 characters. Terminal emulator 17a also maintains the
36 data structures within virtual terminal buffer 19. Input
37 data processor 20 performs any rule-directed processing,
38

1 then passes the characters to virtual window manager 26.
2 Virtual window manager 26 maintains the virtual window
3 buffer 27 in a manner which allows optimal updating of
4 the workstation screen display. Virtual window buffer 27
5 provides buffering until the bit map update manager (Fig.
6 4) is activated to update the display screen. The host
7 data stream input subsystem allows the system to inject a
8 "pseudo host" data stream into the processing cycle by
9 way of the virtual data stream input port 29.

10

11 To perform its functions, terminal emulator 17a
12 follows the program provided by the sequence and execu-
13 tion tables within the terminal emulator rules. The
14 result is the updated contents of the virtual terminal
15 buffer (for both host and local operations) and, where
16 necessary, activation of the AIM input data processor.

17

18 When the terminal emulator retrieves a character
19 from the input FIFO, the characters are (host application)
20 terminal-specific and, generally, of two types:

- 21 1. Data characters which are translated to their
22 ASCII representation before being stored in
23 virtual terminal buffer 19.
- 24
25 2. Control characters which indicate terminal
26 control operations and are translated to a
27 universal representation. In this application,
28 the term "universal" is used to indicate a
29 predefined, internal representation used by the
30 workstation software. The universal represen-
31 tation has various forms. The control characters
32 may be translated to:

33

34 A set of pointers to a structure within
35 the virtual terminal buffer (e.g., the
36 general result of explicit cursor address-
37 ing commands).

38

1 A set of bits within the virtual terminal
2 buffer (e.g., the result of explicit
3 character attribute commands such as set
4 intensity, underline, reverse video,
5 etc.).

6
7 The presence or absence of data at a given
8 position within the virtual terminal
9 buffer (e.g., the result of explicit
10 screen operations such as clear to end of
11 line, etc.).

12
13 Combinations of the above as a result of
14 explicit control sequences (e.g., clear
15 screen, which normally repositions the
16 cursor) or, more usually, as the result of
17 implicit control operations (e.g., most
18 operations involving data characters cause
19 a repositioning of the cursor and will
20 often imply a change to the associated
21 character attributes).

22
23 After the virtual terminal buffer 19 has been updated,
24 ALM input data processor 20 is called. The call to
25 the input data processor specifies the operation and
26 the character(s) affected by the operation.

27
28 Virtual terminal buffer 19 contains a terminal-
29 independent version of the host's application screen.
30 The information is the result of characters which
31 have arrived from the host and have been processed
32 by the various components of the communication
33 module and input terminal emulator 17a. The buffer 19
34 contains, in its universal representation, all the
35 host's screen information and is the reference point
36 for interaction with the host application and for
37 local terminal emulation functions.

38

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1 AIM input data processor 20 is the portion of the
2 AIM which performs the majority of the screen trans-
3 lations from what the host application generates to
4 that which the user views and interacts with.
5 Processor 20 receives information from the terminal
6 emulator 17a which indicates the operation performed
7 by emulator 17a and the character(s) affected by the
8 operation. Processor 20, after completing its
9 operations, passes the characters and operations to
10 virtual window manager 26.
11
12 Virtual window manager 26 maintains the data struc-
13 tures within virtual window buffer 27. When manager 26
14 is passed a character by processor 20, the characters
15 are terminal-independent and, generally, are of two
16 types, as indicated above for terminal emulator 17.
17
18 Data characters indicate displayable characters
19 to be stored in the virtual window buffer.
20
21 Control characters indicate screen or window
22 control operations used in universal represen-
23 tation. These control characters are of the
24 type discussed above in connection with terminal
25 emulator 17.
26
27 Virtual window buffer 27 contains the user's view of
28 the host's application screen. The information is
29 the result of buffer 27 information translated by
30 processor 20. Buffer 27 is the reference point for
31 interaction with the user for both host-oriented and
32 for local emulator functions. The buffer information
33 is accessed by the bit map update to present the
34 user's screen display.
35
36
37
38

1 Display Processing

2 The display processing subsystem (Fig. 4) manages
3 the bit map update functions used to generate the display.
4 Based upon the elapsed time, the central event/time
5 monitor 10 activates the bit map update manager 30 which,
6 in turn, activates the native bit map update routines as
7 shown in Fig. 5, display update.

8
9 Display Update

10 The display update subsystem performs the bit map
11 update of the workstation display. Based upon the elapsed
12 time, the central event/time monitor 10 activates the
13 native environment bit map update routines 43.

14
15 The central event/time monitor, based upon the
16 elapsed time and the current state of virtual window
17 buffer 27, periodically activates the native environment
18 bit map update 43. The native environment bit map update
19 is part of the native operating system and is used to
20 generate the user's display. The update uses virtual
21 window buffer 27 and the display font 53 to generate the
22 display. Display fonts 53 are the tables used by the
23 native environment bit map update to generate the various
24 displayable characters.

25
26 Keystroke Processing

27 The keystroke processing subsystem (Fig. 6) performs
28 the AIM keyboard processor portion of the mouse and
29 keyboard processor functions identified in Fig. 1. The
30 keystroke processing subsystem contains the physical
31 keyboard processor 23, menu key processor 24, AIM keystroke
32 processor 25 and output terminal emulator functions.
33 Based upon events from the keyboard, the central event/time
34 monitor 10 activates the physical keyboard processor 23
35 which, in turn, activates menu key processor 24. If the
36 keystroke from the keyboard is equivalent to a menu
37 selection, control is passed to the AIM menu processor 36

38

1 (Figure 7). Other keystrokes are passed to AIM keystroke
2 processor 25, then to output terminal emulator 17b.
3 Terminal emulator 17b, which may also receive keystrokes
4 from the AIM menu and point processors 36, 37, passes the
5 host-destined characters to the output FIFO 38.

6
7 Central event/time monitor 10, in response to keyboard
8 interrupts, generates keyboard data-available events and
9 passes the raw keystroke data to physical keyboard pro-
10 cessor 23. As mentioned above, AIM control table 28
11 contains the data structures required to switch data and
12 operations among the AIMS. Physical keyboard processor 23
13 performs the mapping of the currently-installed, physical,
14 raw keyboard character representation and layout to the
15 logical, keyboard character representation and layout.
16 Processor 23 follows the program provided by the sequence
17 and execution tables within the physical keyboard rules.
18 Physical keyboard processing rules 47 provide the program-
19 ming for the physical keyboard translations. Virtual
20 keystroke input port 48 provides an internal interface
21 point where other parts of the system may inject character
22 stream information (e.g., the emulator when operating in
23 block mode).

24
25 Menu key processor 24 is responsible for recognizing
26 command key sequences which are equivalent to menu choices
27 selected from a pull-down menu by way of a mouse operation.
28 When a menu-equivalent keystroke combination is entered,
29 menu key processor 24 generates an event equivalent to
30 that which the mouse event decoder 40 (Fig. 7) would
31 generate. The event is then passed to the AIM menu
32 selection processor 36. AIM keystroke processor 25 is
33 the portion of the AIM which performs the majority of the
34 user translations from what the user generates to that
35 which the host application receives and interacts with.
36 Processor 25 is passed keystrokes generated by the user
37 through keyboard or mouse operations. The keystroke

1 processor passes the characters to the output emulator
2 17b. To perform its functions, processor 25 follows the
3 program provided by the sequence and execution tables
4 within the AIM keyboard rules.

5
6 Output terminal emulator 17b passes the data stream
7 generated by both the AIM keystroke and the AIM menu and
8 point processors 25, 36, 37 (resulting from the user's
9 actions) to the output FIFO 38. The emulator also performs
10 the local terminal operations defined for that terminal
11 type. To perform its functions, emulator 17b follows the
12 program provided by the sequence and execution tables
13 within the emulator rules.

14
15 When emulator 17b is passed a character by either
16 the AIM keystroke processor or the AIM menu and point
17 processor, the characters are terminal-independent and,
18 generally, of two types.

19
20 Data characters indicate data and are translated to
21 their terminal-specific representation before
22 being passed to the FIFO 38.

23
24 Control characters trigger the "local", terminal
25 control operations within the emulator.

26 27 Mouse Processing

28 The mouse processing subsystem (Fig. 7) performs the
29 mouse processor portion of the mouse and keyboard processor
30 functions identified in Fig. 1. The mouse processing
31 subsystem contains a mouse event decoder 40, region
32 selector 42, scroll processor 45, AIM point processor 37
33 and AIM menu selection processor function 36. Based upon
34 events from mouse operations, central event/time monitor 10
35 activates mouse event decoder 40. Mouse event decoder 40,
36 based upon the type of mouse operation(s), activates one
37 of the four modules which process mouse operations.

-23-

1 Region selector 42 causes the identification of a
2 workstation screen region, both visually, by displaying,
3 for example, in reverse video for the user, and through a
4 set of coordinates for the workstation software. Selected
5 regions may then be processed by subsequent operations
6 such as cut, copy, etc. When regions are selected which
7 are beyond the boundaries of the current virtual window
8 buffer, region selector 42 activates scroll processor 45
9 to perform the scrolling functions.

10
11 Scroll processor 45 handles the scrolling of the
12 screen display. Scrolling actions are either local,
13 i.e., within the boundaries of the virtual window buffer,
14 or out of bounds of the virtual window buffer. Scrolling
15 beyond the current contents of the virtual window buffer
16 causes the host to perform the scrolling within the
17 application. Using the AIM-supplied scrolling rules,
18 scroll processor 45 is able to interact with the host
19 application, independent of the AIM's involvement, to
20 cause the host to scroll.

21
22 AIM point processor 37 positions the cursor in
23 response to the mouse "point and click" operations.
24 Using the AIM-supplied pointing rules, the AIM point
25 processor is able to interact with the host application,
26 independent of the AIM's involvement, to cause the host
27 to reposition the cursor. AIM menu selection processor 36
28 performs the operations defined for a given menu selection.
29 The operation may either be local, i.e., may cause an
30 action within the workstation, or may direct the host
31 application to perform various operations.

32
33 Central event/time monitor 10, in response to a set
34 of primitive mouse events, passes the events to decoder 40.
35 Monitor 10 is also responsible for determining and setting
36 the priority for the distribution of the mouse-generated
37 events. AIM control table 28 contains the data structures
38 required to switch data and operations amongst the AIMS.

-24-

1 Mouse event decoder 40, in response to the set of
2 primitive mouse events from monitor 10, creates a universal
3 set of mouse-generated events and passes the data to the
4 applicable processor (i.e., region selector, scroll
5 processor, AIM point processor or AIM menu selection
6 processor). Decoder 40 generates a different set of
7 these universal events for each of the four operations to
8 be processed by one of the four mouse-event processors:
9 movement, points, scrolls and menu selections.

10

11 Region selection: When a "mouse down" event, outside
12 the area occupied by the menu bar or a scroll
13 bar, is followed by a "mouse still down" event
14 in another location, decoder 40 passes the
15 beginning coordinates to the region selector 42
16 and enters a passthrough state. Until a "mouse
17 up" event is received, the "mouse still down"
18 events are passed through decoder 40 to region
19 selector 42. When the "mouseup" event is
20 passed to the region selector, decoder 40
21 reenters its decoding state.

22

23 Scrolling: When a "mouse down" event inside the area
24 occupied by a scroll bar is followed by a
25 "mouse still down" event in another location,
26 decoder 40 passes the beginning screen coordi-
27 nates to scroll processor 45 and enters a
28 passthrough state. Until a "mouse up" event is
29 received the "mouse still down" events are
30 passed through the decoder to the scroll pro-
31 cessor. When the "mouse up" event is passed to
32 the scroll processor, the decoder reenters its
33 decoding state.

34

35 Pointing: When a "mouse down" event inside the area
36 occupied by a window is optionally followed by
37 a set of "mouse still down" events, then by a
38

1 "mouse up" event in the same location, decoder 40
2 passes the screen coordinates to AIM point
3 processor 37.
4

5 AIM menu selection: When a "mouse down" event inside
6 the area occupied by the menu bar is followed
7 by a set of "mouse still down" events in another
8 location, then by a "mouse up" event which
9 signifies a valid menu selection, decoder 40
10 passes the menu and item numbers to AIM menu
11 selection processor 36.
12

13 The virtual mouse event input port 48 provides an
14 internal interface point where other parts of the system
15 (e.g., the "learn function" when operating in "playback
16 mode") may inject mouse operation events. AIM menu
17 selection processor 36 performs, for the menu item selected,
18 the set of operations defined by the AIM menu selection
19 processing rules (i.e., what to do when a menu item is
20 selected). AIM menu selection processing rules (shown
21 schematically at 49 in Fig. 7) provide the programming
22 for the processing to be performed as a result of menu
23 selections. AIM point processor 37, based upon the AIM
24 pointing rules (i.e., cursor movement rules), directs the
25 host application to position the cursor to the "pointed
26 to" location. The AIM pointing rules 51 provide the
27 programming for the pointing operations.
28

29 Scroll processor 45 causes data in buffer 27 to
30 scroll. When the scroll operation crosses the boundaries
31 of the current contents of the buffer, the scroll processor,
32 based upon the scrolling rules 52 supplied by the AIM,
33 directs the host application to scroll buffer 19. When
34 the scroll processor receives the "mouse up" event, it
35 updates a data structure which indicates the coordinates
36 of the currently-displayed screen.
37

1 The AIM-supplied scrolling rules 52 provide the
2 programming for the scrolling operations. The AIM supplies
3 the instruction table which the scroll processor uses to
4 "look up" the instructions which it must send to the host
5 application to cause it to perform scrolling operations
6 which are outside the contents of the current buffer 19.
7 Region selector 42 updates buffer 27 to indicate which
8 area of the screen is being selected by the mouse opera-
9 tion. When the region selector receives the "mouse up"
10 event, it updates a data structure which indicates the
11 coordinates of the currently-selected regions. When a
12 region selection crosses the boundaries of buffer 19, the
13 region selector may call the scroll processor to cause
14 the data in buffer 27 to scroll.

15

16 AIM Initialization

17 The AIM initialization subsystem (Fig. 8) consists
18 only of the AIM initialization processor 56 and performs
19 the functions required to get an AIM started. When an
20 AIM is launched, event/time monitor 10 activates the AIM
21 initialization processor 56 which sets the beginning
22 environment for the AIM. Central event/time monitor 10,
23 when control is added for an additional AIM by way of the
24 AIM control table 28, calls the AIM initialization processor.

25

26 AIM control table 28 contains the data structures
27 required to switch data and operations among the AIMS.
28 AIM initialization processor 56 is the portion of the AIM
29 which performs the initialization operations required by
30 the AIM. The AIM initialization processor follows the
31 program provided by the sequence and execution tables
32 within the AIM initialization rules 57 (see Fig. 10--rule
33 processing detail), to perform its functions. AIM initiali-
34 zation rules 57 provide the programming for the initializa-
35 tion operations.

36

37

38

1 AIM Signal Processing

2 The AIM signal processing subsystem (Fig. 9) consists
3 only of AIM signal processor 58 and performs the functions
4 required to respond to various stimuli defined as signals
5 (e.g., events such as create a window or messages such as
6 physical host connection lost, etc.). When such events
7 are received, central event/time monitor 10 activates
8 signal processor 58.

9
10 AIM signal processor 58 is the portion of the AIM
11 which performs the operations required to respond to the
12 signals received. The AIM signal processor follows the
13 program provided by the sequence and execution tables
14 within the AIM signal processing rules 57 to perform its
15 functions.

16 Virtual Terminal and Virtual Window Buffer Detail

17 Virtual terminal buffer 19 contains four major
18 structures:
19

20 Displayable characters:

21 The displayable characters are represented in
22 ASCII format. The position of the characters
23 is represented by their position in a data
24 structure within buffer 19.

25 Display attributes:

26 The display attributes, related to the display
27 as would be presented on the host's terminal
28 being emulated, are represented in a data
29 structure within buffer 19. All attributes
30 which apply to a set of characters, such as set
31 beginning/end of field type, are represented by
32 a single entry for each of the individual
33 characters affected. All attributes, such as
34 display intensity/color, character set, etc.,
35 are represented in this manner. The content
36
37

1 and form of the data structure which contains
2 the representation of the display attributes is
3 dynamic in definition. That is, the meaning/use
4 of the fields within the data structure is
5 defined by the input terminal emulation rules.

6
7 Virtual window mapping:

8 The corresponding position, if any, of a terminal
9 buffer 19 character within the window buffer 27
10 is maintained. That is, every displayable
11 character in the buffer 19 has a corresponding
12 pointer which indicates whether or not it is
13 contained within the window buffer and, if so,
14 where it is located within the window buffer.

15
16 Portions of the virtual window mapping may be
17 defined as active by the AIM. Active mapping
18 areas provide the ability to cause screen
19 information from a particular area within the
20 terminal buffer 19 to be automatically placed
21 in the window buffer in a specified position,
22 with the attributes set up in the window buffer.
23 This function can be performed by the terminal
24 emulator 17a without further interaction from
25 the AIM.

26
27 Most recent character changes:

28 Since certain terminal command sequences change
29 sets of characters, a data structure is main-
30 tained to keep track of the lines which contain
31 changes.

32
33 Virtual window buffer 27 contains four major struc-
34 tures. The structures for displayable characters, display
35 attributes and virtual mapping are essentially the same
36 as those described above for the structures of virtual
37 terminal buffer 19.
38

1 Window buffer 27 also contains the following struc-
2 tures.

3 Most recent region changes:

4 Since the update of the workstation screen is
5 performed on the basis of time, a data structure
6 is maintained to keep track of the regions which
7 contain changes since the previous update.

8

9 Rule Processing Detail

10

11 The various rule processors (Fig. 10) form the back-
12 bone of the AIMS. The rule processor is a translator
13 which accepts stimuli (i.e., the input sequence), parses
14 the stimuli, then executes a specified set of functions
15 as a result of the stimuli. In essence, the rule processor
16 is a set of state machines driven by the input sequence 61
17 and various states. In this use, a state is synonymous
18 with a condition or a status.

19

20 Logically, there are two such state machines, the
21 sequence recognizer 62 and the rule executor 63. The
22 commands are determined by the type of stimuli and speci-
23 fied by the sequence table 64. The capabilities of the
24 "language" represented by the state machine are determined
25 by the execution table 66. Generally, the functions
26 which are executed as a result of this process are
27 routines with a high level of functionality with respect
28 to the workstation's tasks.

29

30 Sequence recognizer 62 is the language parser portion
31 of the translator. The input sequence 61 is parsed by
32 matching against sequence table's 64 entries, including
33 the recognizer state 57. When a match is found, the
34 sequence table entry points to a specific rule within the
35 execution table 66. Control is then passed to the rule
36 executor 63.

37

38

1 Sequence table 64 contains the parsing sequences
2 which the rule processor recognizes as commands. In this
3 respect, the sequence table defines the language under-
4 stood by the rule processor. In addition to the command
5 sequence definition, the sequence table also points to
6 the associated function set to be executed as a result of
7 that command. The sequence table has the structure shown
8 in Fig. 11.

9
10 Condition name:

11 The meanings of the terms used in the example of
12 Fig. 11 are as follows, assuming that the example is
13 for AIM menu selection processing for a word process-
14 ing/editor interface which has a pull-down menu.
15 Fig. 11 also assumes that changing the mode setting
16 changes the menu entry to allow a user to change to
17 the other mode and that when exiting the insert
18 mode, the current line of text must be justified if
19 that portion of text is set to be justified.

20
21 The condition name provides a user-oriented name for
22 the sequence recognizer line entry. The line entry
23 defines the recognizable state which leads to the
24 selection of the rule set to be executed.

25
26 Set of states:

27 The fields which make up the set of states (to be
28 recognized) are dynamically defined during the
29 specification of the sequence table. These fields
30 include both local and other states.

31
32 Input sequence:

33 The input sequence is the multi-byte input to the
34 recognizer; for example, the arriving characters in
35 the case of the terminal emulator. The input sequence
36 is parsed based upon the current values of the set
37 of states specified. The result is the identification
38 of the rule set to be executed.

1 Rule set name:

2 The rule set name provides a user-oriented name for
3 the set of rules to be executed.
4

5 Recognizer State:

6 The recognizer state contains the current, local
7 status information for the sequence recognizer. Local
8 states may be defined during the specification of the
9 execution table.
10

11 Rule Executor:

12 The rule executor performs the command execution
13 functions within the translator. The rule executor has
14 the constructs to perform the flow control operations
15 which are equivalent to the more traditional grammars
16 specified as "continue", "goto", "break", "exit",
17 "if....then....else....", "for....do....done" and
18 "while....do....done". The rule executor also resolves
19 symbolic references contained in the rule line entry.
20 The symbolic references may come from the input sequence
21 or from the execution table. When the references have
22 been resolved, the rule executor passes control to the
23 functions to be executed.
24

25 Execution table:

26 The execution table shown in Fig. 12 contains the
27 sets of entries which the rule executor interprets to
28 perform the commands indicated in the sequence table. In
29 this respect, the execution table defines the capabili-
30 ties of the rule processor. The terms in the execution
31 table have the following meanings:
32

33 Rule name:

34 The rule name provides a user-oriented name for the
35 set of rules to be executed.
36
37

1 Set of states:

2 The fields which make up the set of states to be
3 recognized are dynamically defined during the speci-
4 ficaton of the rules. These fields include both
5 local and other states.

6

7 Function:

8 The function is the name of the function to be
9 executed. Ultimately, it must be a name which can
10 be resolved to a known C-code function. Externally,
11 it may be mapped, through the use of the developer
12 tools and tables, to a more human-useable form.

13

14 Parameters:

15 The parameters are the parameters to be passed to
16 the function being executed. Parameters which are
17 symbolic names must be resolved to the C-code level.
18 Externally, they may be mapped, through the use of
19 the developer tools and tables, to a more user-oriented
20 form.

21

22 (Sets of:) new states:

23 The new states are the settings for the local states.
24 These states may be in addition to the states main-
25 tained by the functions themselves. This allows the
26 AIM specifier to create states as required to indicate
27 the state of the host application (e.g., Mode:
28 Insert or Overtyp). The fields which make up the
29 set of states to be recognized are dynamically
30 defined during the specification of the rules.

31

32 (Sets of:) next rule:

33 The next rule is the name of the next rule to be
34 executed. The lack of an entry indicates the next
35 sequential rule entry. The next rule may also
36 indicate a rule set as a subroutine.

37

38

1 Executor state:

2 The executor state 68 contains the current, local
3 status information for the rule executor.
4

5 Although the sequence and execution tables are
6 explained as two separate units, that particular division
7 is used only as a model. The actual implementation may
8 range from a single-table version for a simple rule
9 processor which uses a linear interpretation scheme to a
10 version which uses different tables and corresponding
11 state machines for such elements as the input sequence
12 parsing, the current state parsing, the actual function
13 execution, etc.
14

15 Technology.

16 Although the workstation concept described herein is
17 based upon common, commercially-available hardware tech-
18 nology, it is the price-performance ratio of this proven
19 hardware technology in combination with some of the most
20 recent software technology in the user-interface area
21 which makes the described workstation a practical invention
22 today. However, since it is obvious that neither the
23 hardware nor the software technology will stagnate, the
24 invention, from its concept to its architecture and
25 engineering, is designed to embrace improved hardware and
26 software technologies. As the cost per unit of performance
27 of the hardware continues to decline and as new or improved
28 user-interface software becomes commercially practical,
29 the described invention will be able to incorporate these
30 concepts without changing its basic concept or even its
31 basic architecture.
32

33 There have been two major developments in the hardware
34 technology which make the invention described above
35 commercially viable. The first was the development of
36
37
38

1 physically small, inexpensive computers based upon micro-
2 processors in the class usually referred to as "super-
3 micros". The second development was the commercial
4 production of the first type of computers with companion
5 printers which have graphic capabilities with enough
6 resolution to present the type of display screen and
7 printed material required by the "iconic", graphics-based
8 types of presentation used by the present user-interface
9 software and hardware technology.

10

11 An early implementation of the invention involved
12 the use of the technologies mentioned above in an unmodi-
13 fied form. That is, the workstation software used existing
14 microprocessors along with the existing Read-only Memory
15 (ROM), semiconductor Random Access Memory (RAM) and
16 external mass storage in the form of disks, both low-
17 capacity, flexible disks and medium-capacity, hard disks.

18

19 Various hardware trends apparent today will make the
20 described invention easier to implement in the future.
21 Various implementations such as Commodore's Amiga computer
22 are making extensive use of dedicated hardware modules to
23 support the graphics functions required. This approach
24 will greatly improve the price-performance ratio of the
25 hardware. Future generations of the present workstation
26 may use various combinations of ROM, alternative RAM
27 technology, alternative disk technology and/or alternative
28 microprocessor technology.

29

30 For example, it would be natural to supply various
31 versions of the workstation with the run-time system
32 contained in ROM. Similarly, it would be practical to
33 develop certain "fixed-product" workstations for use as
34 specific monitors in areas such as process control, which
35 contained even the AIM in ROM. In general, the only
36 portions of the architecture which are not implementable
37 in ROM are the dynamic data structures.

38

1 Many of the portions of the architecture could also
2 be implemented using combinatorial, sequential and/or
3 microcoded, processor-based logic. Modules such as the
4 direct, native environment interfaces would be prime
5 candidates for this approach. In the area of micropro-
6 cessors, developments such as Intel's "transputer"
7 technology may be used to provide separate computers for
8 the various asynchronous units within the present
9 architecture.

10
11 There has been one major development in the software
12 technology which makes the workstation concept attractive;
13 the development of, and industry acceptance of, the
14 various approaches to the windowed, iconic, graphics-
15 oriented user-interface presentations, available as
16 mass-produced, inexpensive software development tools for
17 the "super micros" mentioned above.

18
19 One embodiment of the present invention utilizes an
20 Apple Macintosh computer to provide a multisession,
21 terminal emulator with the majority of the features
22 specified for the IBM 3270 terminal. The product, in
23 combination with Tri Data Corporation's Netway 100Ca
24 communication protocol converter, interfaces to IBM
25 computers via Bisynchronous (BSC) or Systems Network
26 Architecture (SNA)/Synchronous Data Link Control (SDLC).

27
28 The present workstation software can be implemented
29 on any computer which provides the computing and graphics
30 capability required to present a windowed, iconic, graphical
31 style of user interface. In practical terms, commercial
32 versions are most readily produced utilizing computers
33 which provide the tools to expedite development. Such
34 computers available today are the Apple Macintosh and the
35 IBM PC/XT/AT with the Microsoft Windows environment.
36 Other possibilities available today are the Atari 520ST
37 computer and the Commodore Amiga computer.
38

1 The windowed, iconic, graphical style of user inter-
2 face commercialized by the Xerox Star product and exempli-
3 fied by the Apple Macintosh is generally considered the
4 best user interface technology available today. In that
5 respect, the present workstation retains the presentation
6 of the user interface as provided for by the Native
7 Environment upon which it is based (e.g., the Apple
8 Macintosh or the IBM PC/XT/AT). However, it should be
9 noted that the current architecture embraces new and/or
10 completely different presentations of user interface
11 technologies as they become available. For example, with
12 the commercial viability of speech recognition and accurate,
13 intelligible voice synthesis, compatible AIMS for these
14 products can be implemented.

15

16 In general, any new user interface technology may be
17 added to the architecture of the present invention.
18 Technologies which deal with output to the workstation
19 user are interfaced through a module which translates the
20 host's presentation (via the host's screen) to the new
21 presentation format for the user. Technologies which
22 deal with input from the user are interfaced through a
23 module which translates what the user does, as input,
24 relative to what the user interacts with (e.g., the
25 workstation's screen), to what the host understands as
26 valid input from the terminal it thinks it is communicating
27 with.

28

29 Attached hereto as Appendix A are copies of computer
30 programs written in C code showing implementation of the
31 present invention. Appendix A includes the following:

- 32 1. Central event monitor 10, parts 1, 2 and 3;
- 33 2. FITOS (Operating System Desk Top Initiator);
- 34 3. FITOS (Operating System Tool Box Functions;
- 35 4. Host Interface Routines For Serial Asynch
- 36 multichannel;

37

38

-37-

- 1 5. AIM Initialization Routine;
- 2 6. Emulation of H(Heathkit)19 terminal as an AIM;
- 3 7. AIM--Virtual Terminal Support Module;
- 4 8. AIM--Virtual Terminal Library;
- 5 9. AIM--Graphic Window for Multiplan AIM.
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CLAIMS

1. A system for executing a computer application program in a host computer (11) under the control of a second computer located at a workstation and including a display screen (13), characterised by:

means for translating selected portions of the host computer's presentation information into functionally equivalent user-oriented presentation information for use in the second computer; and

means for translating a user's responses to the user-oriented presentation information at the second computer into response information for use in the host computer to interact with the application program.

2. A system as claimed in claim 1 characterised by an input terminal emulator (17a) which emulates a terminal at the workstation, means for supplying the host computer's presentation information to the terminal emulator, and means for utilizing the output of the terminal emulator to produce the functionally equivalent user-oriented presentation information.

3. A system as claimed in claim 2 characterised by means for supplying at least some of the output of the input terminal emulator (17a) to a virtual terminal buffer (19) for buffering of the at least some of the terminal emulator output.

4. A system as claimed in claim 3 characterised by means for processing selected outputs of the terminal emulator (17a) and the virtual terminal buffer (19) in an application interface module (21), the module processor processing its inputs in accordance with characteristics of the application program to be executed in the host computer (11).

5. A system as claimed in claim 4 characterised by means for supplying the product of the application

interface module processor (21) to a virtual window manager (26) for controlling the display screen (13).

5 6. A system as claimed in claim 3 characterised by means for supplying at least some of the output of the terminal emulator (17a) to a virtual window buffer (27) to buffer information to be displayed on the display screen (13).

10 7. A system for executing a computer application program in a host computer (11) under the control of a secondary computer having a display screen (43) and a user-friendly interface, characterised by:

15 a communication function module (16) connected to the host computer, the communication function module receiving information from the host computer and transmitting information from the second computer to the host computer;

20 an input terminal emulator (17) connected to the communication function module for translating information received by the communication function module from the host computer into functionally equivalent user-oriented presentation information for use in the second computer;

25 a virtual window buffer (27) for receiving information from the input terminal emulator; and

means responsive to information from the virtual window buffer for controlling the display screen in response to execution of the application program in the host computer.

30 8. A method of executing a computer application program in a host computer (11) under the control of a second computer located at a workstation and including a display screen (13), characterised by the steps of;

35 translating selected portions of the host computer's presentation information into functionally equivalent user-oriented presentation information

for use in the second computer; and

translating a user's responses to the user-oriented presentation information at the second computer into response information for use in the host computer to interact with the application program.

5 9. A method as claimed in claim 8 characterised by the steps of supplying the host computer's presentation information to an input terminal emulator (17a) which emulates a terminal at the workstation, and
10 utilizing the output of the input terminal emulator to produce the functionally equivalent user-oriented presentation information.

10. A method as claimed in claim 9 characterised by the step of supplying at least some of the output of
15 the input terminal emulator (17a) to a virtual terminal buffer (19) for buffering of said at least some of the terminal emulator output.

11. A method as claimed in claim 10 characterised by the steps of processing selected outputs of the
20 input terminal emulator (17a) and the virtual terminal buffer (19) in an application interface module processor (21), the module processor processing its inputs in accordance with characteristics of the application program to be executed in the host
25 computer.

12. A method as claimed in claim 11 characterised by the step of supplying the output product of the application interface module to a virtual window
manager (26) for controlling the display screen (13).

30 13. A method as claimed in claim 10 characterised by the step of supplying at least some of the output product of the terminal emulator (17a) to a virtual window buffer (27) for buffering information to be displayed on the display screen (13).

14. A method as claimed in claim 12 characterised by the step of supplying at least part of the output product of the window manager (26) to a virtual window buffer (27) for buffering information to be displayed on the screen.

15. A method as claimed in claim 14 characterised by the step of supplying at least part of the output of the terminal emulator (17a) to the virtual window buffer (27).

16. A method as claimed in any preceding claim characterised in that the workstation comprises a keyboard (12), and in that the translation of a user's responses includes transmitting information from the keyboard at the workstation to the host computer (11).

17. A method as claimed in claim 17 characterised by the steps of;

supplying the information from said keyboard (12) to an output terminal emulator (17b) which emulates a terminal at the host computer 11; and

utilizing the output of the output terminal emulator to produce the response information for use in the host computer.

18. A method as claimed in claim 17 characterised by the step of supplying the output of the output terminal emulator (17b) to a first-in first-out buffer (38) for buffering the output terminal emulator output.

19. A method as claimed in any one of claims 1 to 16 characterised in that the workstation comprises a mouse (12), and in that the translation of a user's responses includes transmitting information relative to movement of the mouse at the workstation to the host computer (11).

20. A method as claimed in claim 19 characterised by the steps of:

supplying the information relative to movement

of the mouse to an output terminal emulator (17b) which emulates a terminal at the host computer (11); and

utilizing the output of the output terminal emulator to produce the response information for use in the host computer.

21. A method as claimed in claim 20 characterised by the step of supplying the output of the output terminal emulator (17b) to a first in--first out buffer (30) for buffering the output terminal emulator output.

22. A method of executing a computer application program in a host computer (11) under the control of a second computer having a user-friendly interface, characterised by the steps of:

generating a plurality of application interface module programs for a plurality of the application programs, each of the application interface module programs being arranged to be executed in the second computer to cause execution of the corresponding one of the application programs in the host computer;

transmitting a selected one of said application interface module's programs to the second computer; and

executing the selected one of the application interface module programs in the second computer using the user-friendly interface to produce execution of the application program in said host computer.

23. A method as claimed in claim 22 characterised by the steps of storing a plurality of the application interface module programs in the host computer.

24. A method of developing an application interface module for controlling the program in a host computer (11) under the control of a second computer located at a workstation, characterised by the steps of:

editing rule tables relating to application-specific interface operations for controlling the translation of selected portions of the host computer's presentation information into functionally equivalent user-oriented presentation information for use in the second computer and for controlling the translation of a user's responses to the user-oriented presentation information at the second computer into response information for use in the host computer to interact with the application program.

POLLAK
MERCER &
TENCH

0237671

13 May 1987

European Patent Office
P B 5818
Patentlaan 2
2280 HV Rijswijk (ZH)
Netherlands

Dear Sirs

Application ~~86~~ 308 395.2
Mitem Development Partners
Our Ref M-356

I refer to the invitation to remedy deficiencies dated 18 December 1986 the term for response to which was extended by the communication dated 4 March 1987 until 18 May 1987.

It has now been decided that the best course would be to cancel Appendix A from the application, and cancellation of Appendix A is accordingly hereby now requested.

It is understood that formal drawings have now been received and are acceptable, so the present request for cancellation deals satisfactorily with all the formal deficiencies to which objection was taken.

Yours faithfully
POLLAK MERCER & TENCH



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P.J. MASSAAR 12 JUN 1987



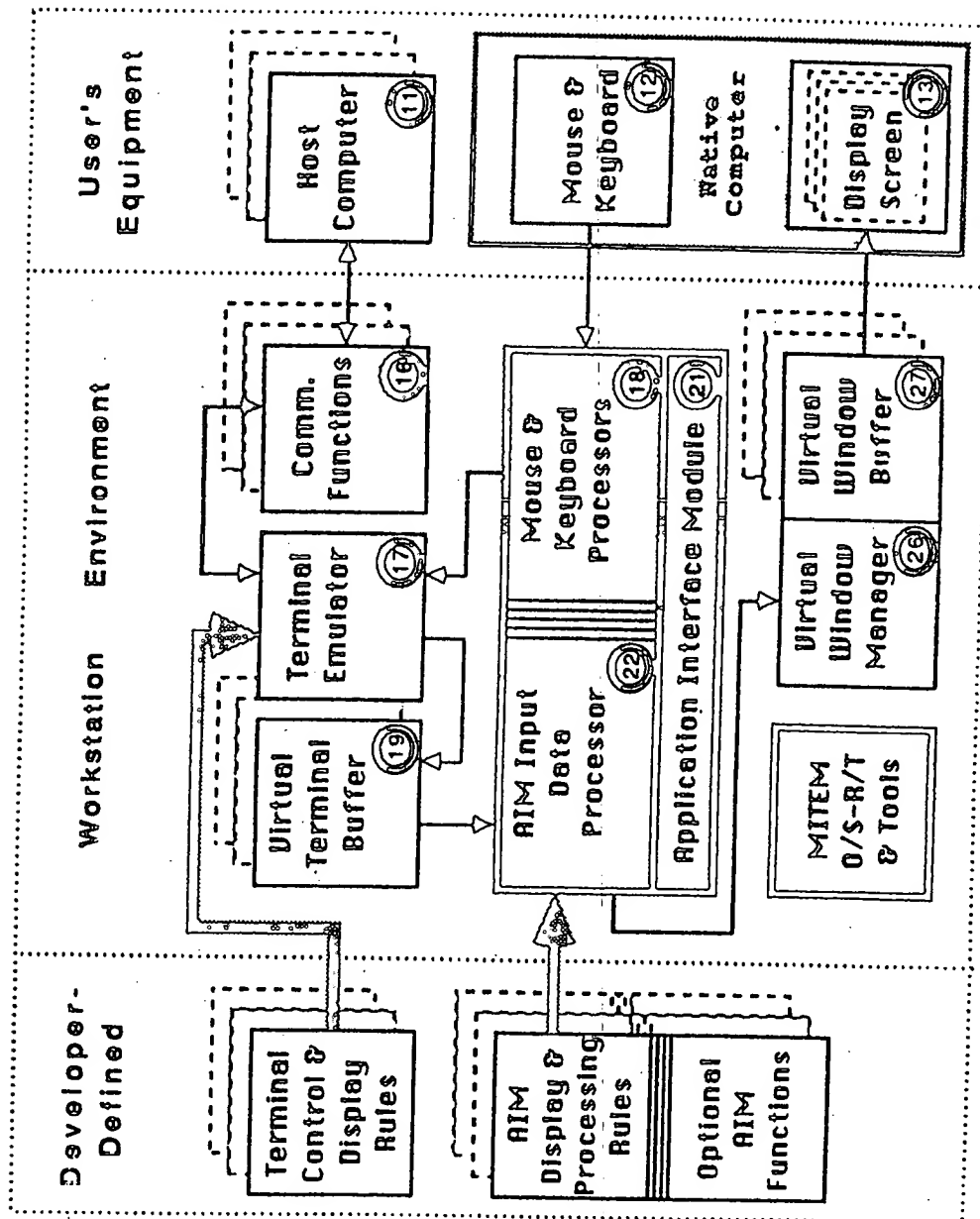


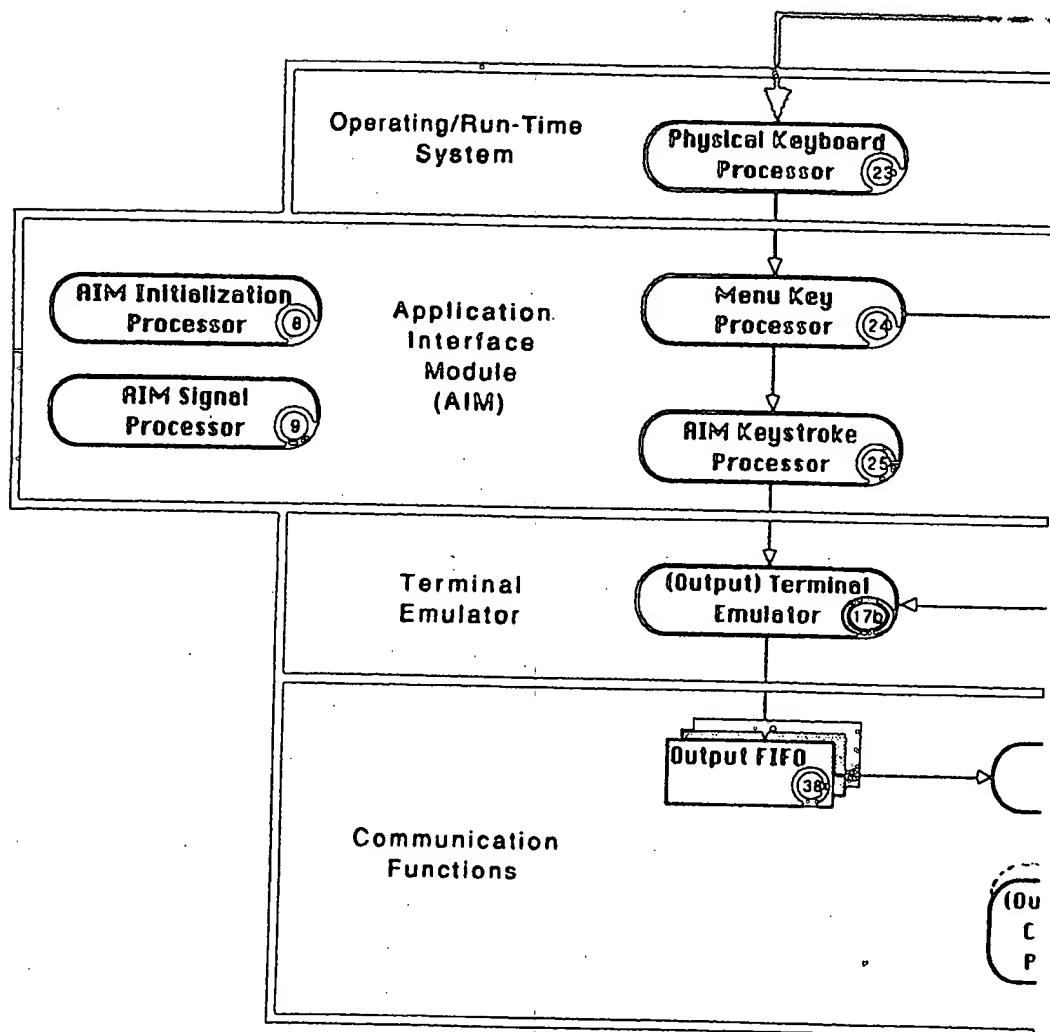
Figure 1
Architecture Overview

[illegible]

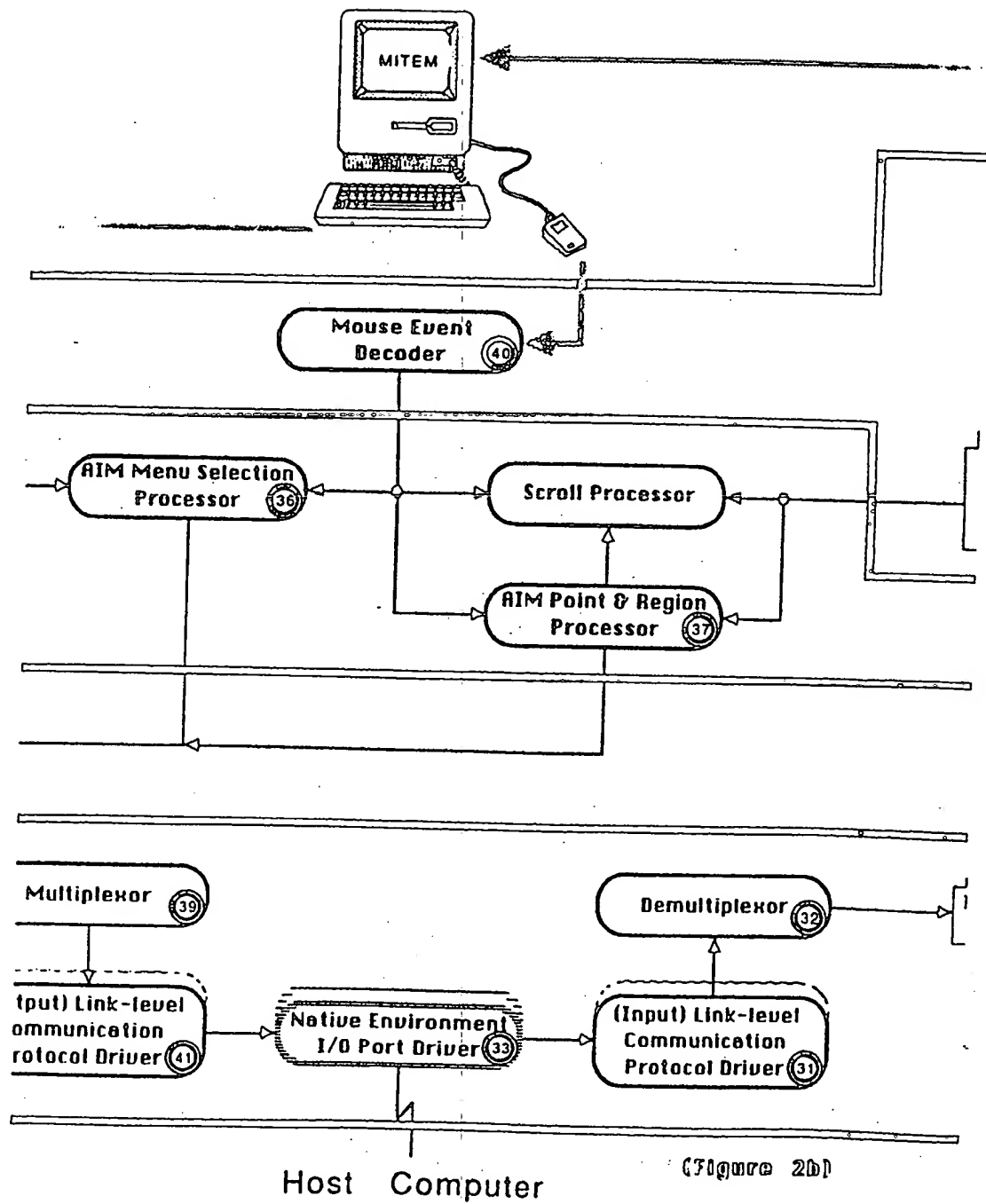
1980-1981

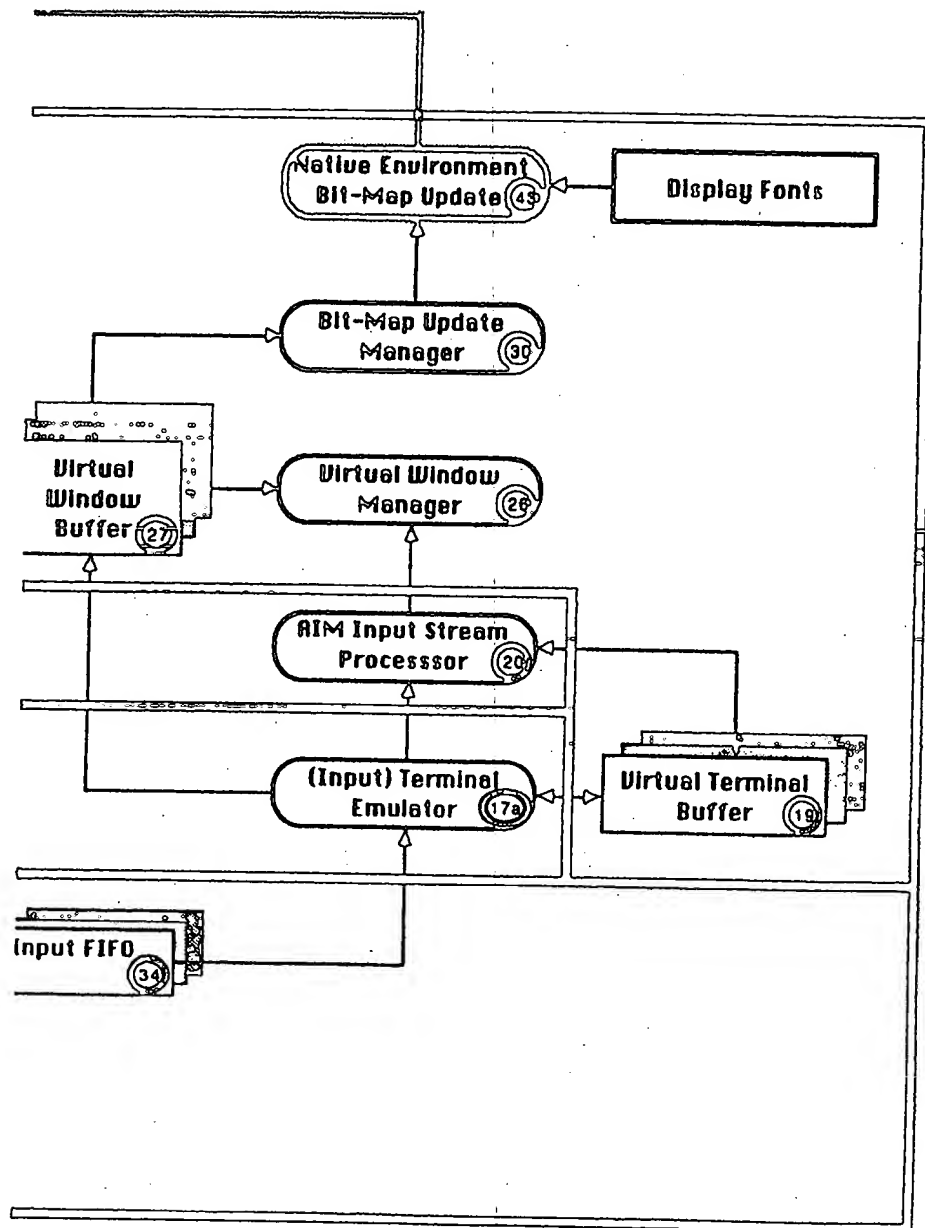
Host
Computer

Figure 2
System Information Flow



(Figure 2a)





(Figure 2c)

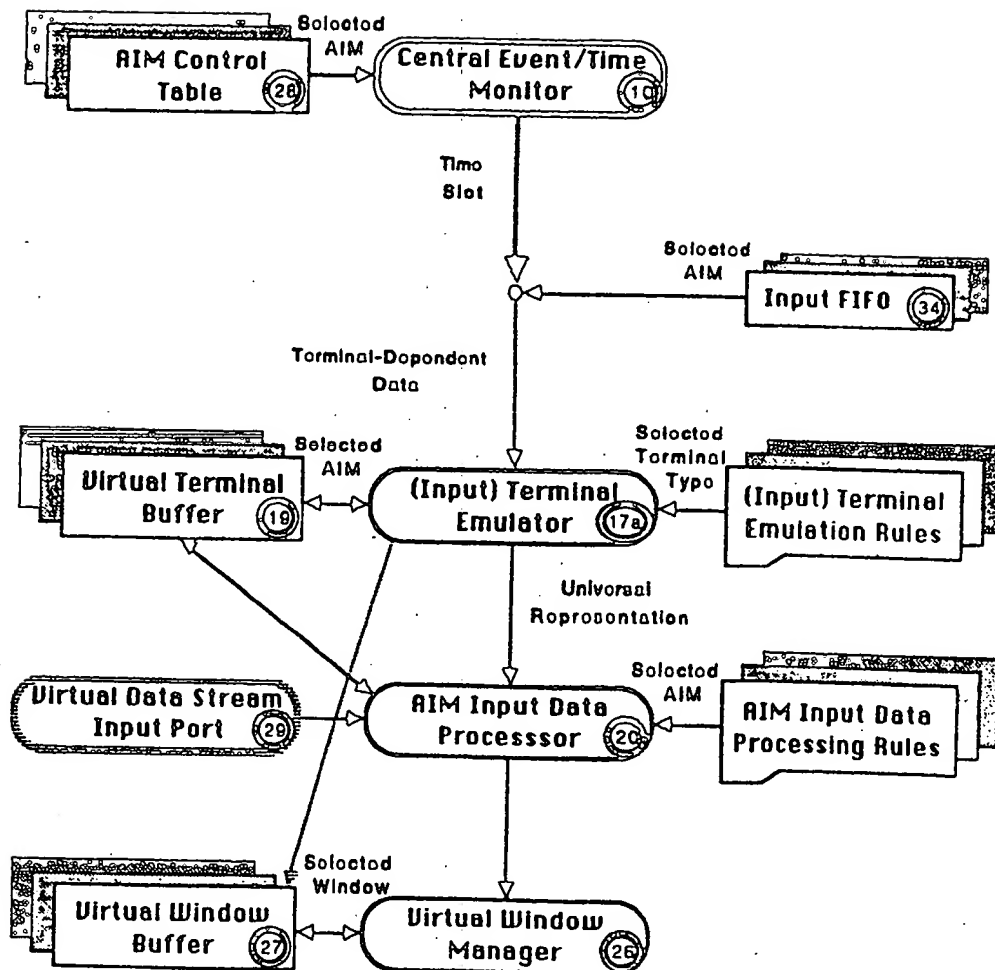


Figure 3
Input Stream Processing

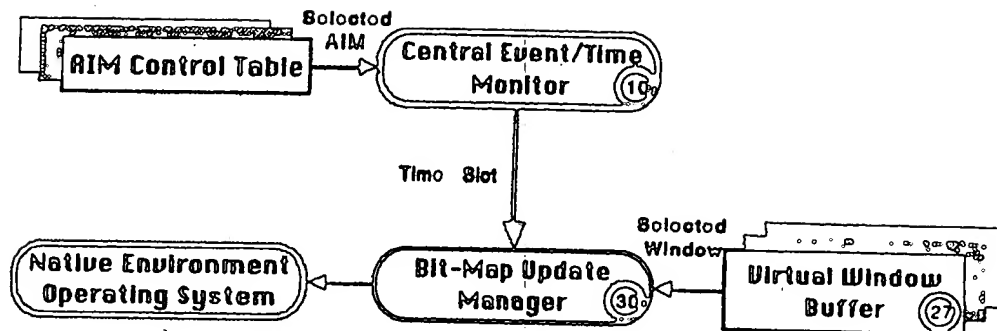


Figure 4
Display Processing

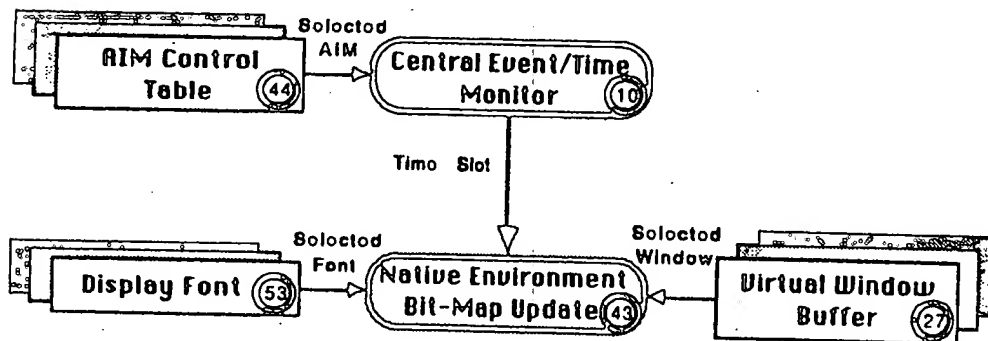


Figure 5
Display Update

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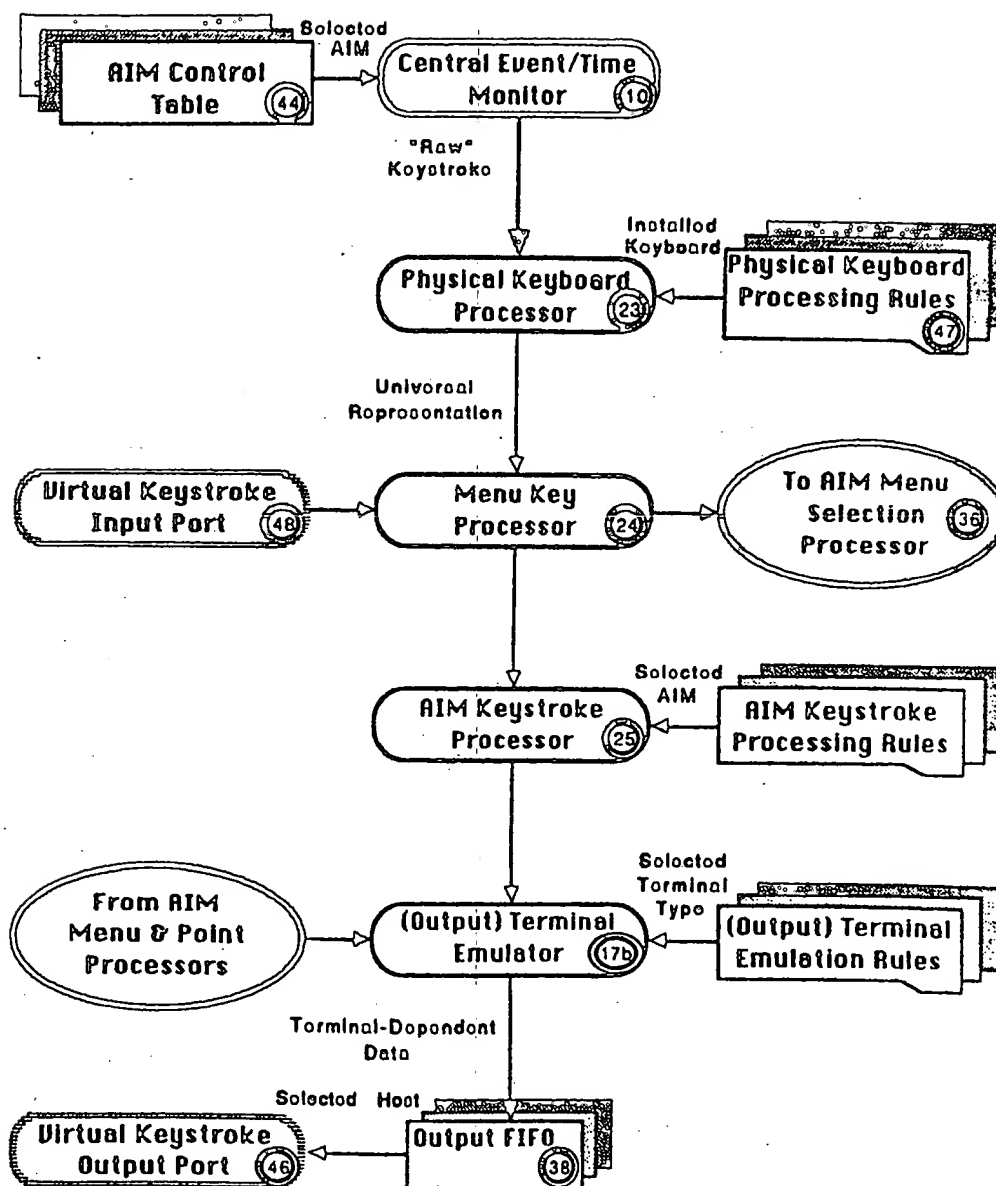


Figure 6
Keystroke Processing

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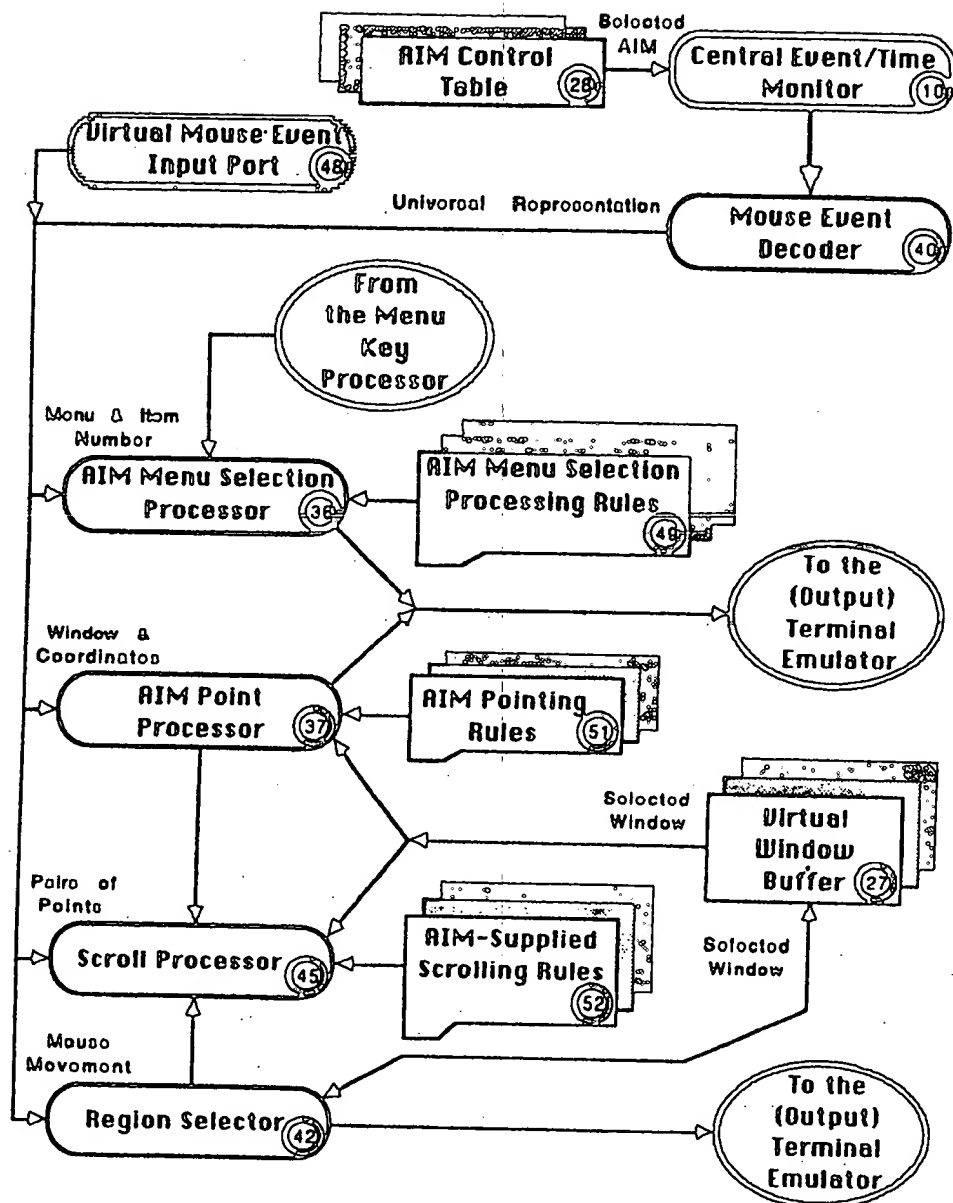


Figure 7
Mouse Operation Processing

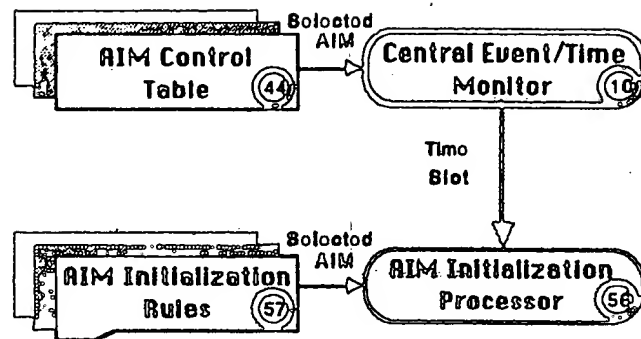


Figure 8
AIM Initialization

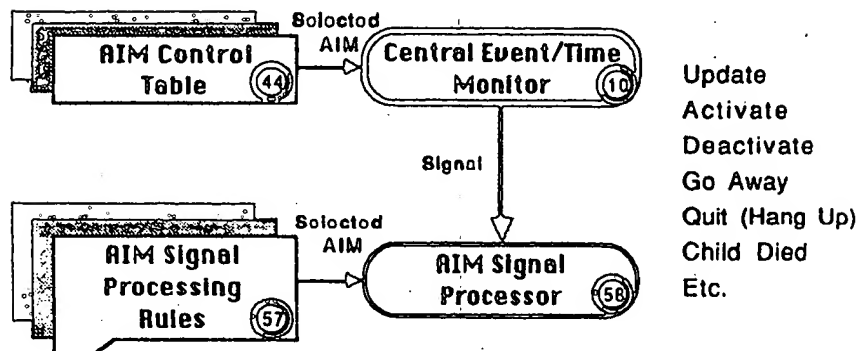
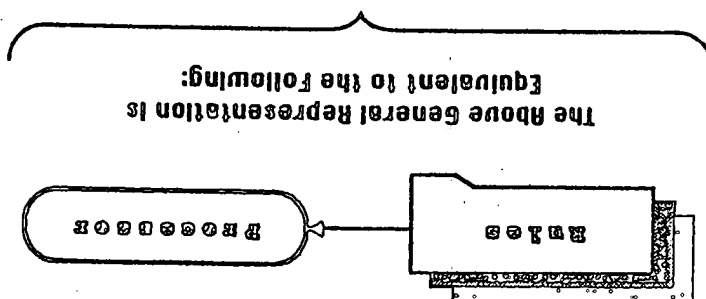


Figure 9
AIM Signal Processing



The Above General Representation is
Equivalent to the Following:

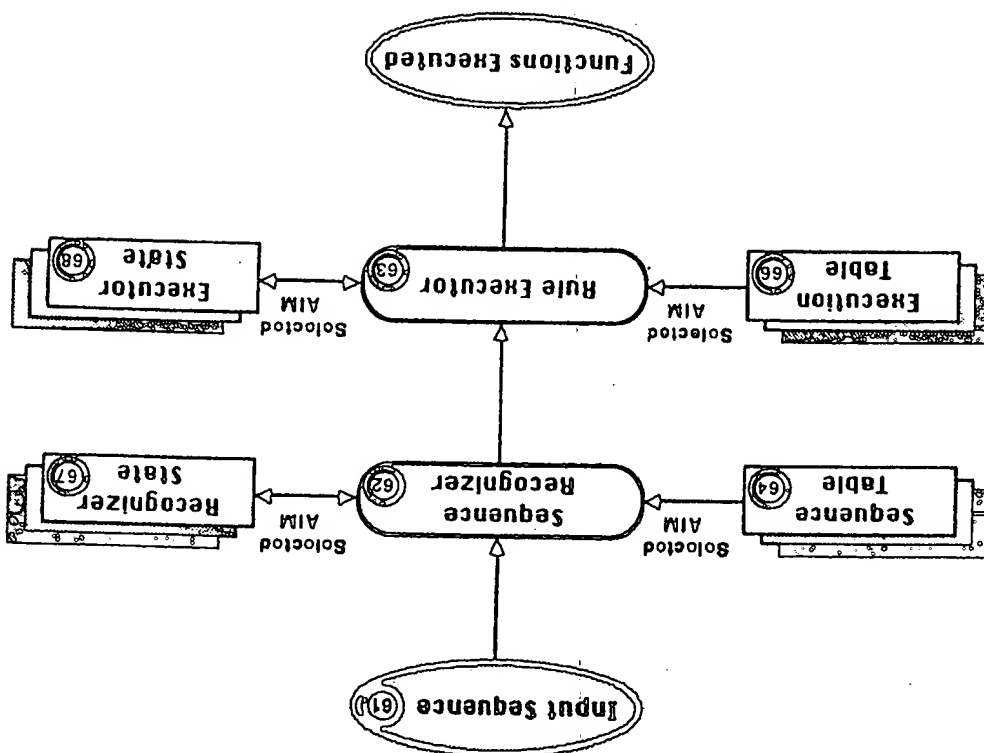


Figure 10
Rule Processing Detail

Condition Name	Set of States		Input Sequence		Rule Set Name
	Edit Mode	Insert/Typeover Mode	Menu Name	Menu Entry	
Non-Edit Mode	Off	Don't Care	Don't Care	Don't Care	N/A
Edit/Insert Mode	On	Insert	Editor Modes	Set Insert	N/A
Edit/Typeover	On	Typeover	Editor Modes	Set Insert	Set Typeover
	On	Typeover	Editor Modes	Set Typeover	Set Insert
	On	Typeover	Editor Modes	Set Typeover	N/A

Figure 11
Rule Specification Example - Sequence Table

Rule Name	Set of States Justification Mode	Function	Parameters		New States Insert/Typeover Mode	Next Rule
Set Insert	N/A	ChgMenuEntry	Editor Modes, Set Typeover, Set Insert		Insert	Next Line
	N/A	SetCursorType	Insert Cursor		N/A	End
Set Typeover	None	N/A			N/A	Define T/O
	Left-Right	JustifyLR	Current Line		N/A	Define T/O
Define T/O	N/A	ChgMenuEntry	Editor Modes, Set Insert, Set Typeover		Typeover	Next Line
	N/A	SetCursorType	Typeover Cursor		N/A	End

Figure 12
Rule Specification Example - Execution Table